ORIGINAL ARTICLE

Year : 2000 | **Volume** : 48 | **Issue** : 4 | **Page** : 301-6

Visual field assessment in glaucoma: Comparative evaluation of manual Kinetic Goldmann Perimetry and Automated Static Perimetry

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PMID: 11340889

Abstract

Purpose: To compare the detection and assessment of progression of visual field defects in primary open-angle glaucoma with manual suprathreshold perimetry on Goldmann perimeter and automated static threshold perimetry on Humphery visual field (HVF) analyzer. **Methods:** 105 eyes of 54 patients of primary open-angle glaucoma were followed up with 3-monthly perimetry on Goldmann perimeter and HVF analyzer, for a period of 9 months. **Results:** HVF analyzer picked up visual field defects in 48 (46%) eyes whereas Goldmann perimeter picked up visual field defects in 26 (25%) eyes. HVF analyzer demonstrated progression in 14 eyes whereas Goldmann perimeter detected progression in 7 eyes during follow up of 9 months. **Conclusions:** HVF analyzer is superior to Goldmann perimeter to document and to demonstrate progression of visual field defects in primary open-angle glaucoma.

Keywords: Adolescent, Adult, Aged, Aged, 80 and over, Automatic Data Processing, Comparative Study, Female, Glaucoma, Open-Angle, diagnosis, physiopathology,

How to cite this article:
Agarwal HC, Gulati V, Sihota R. Visual field assessment in glaucoma: Comparative evaluation of manual Kinetic Goldmann Perimetry and Automated Static Perimetry. Indian J Ophthalmol 2000;48:301

How to cite this URL:
Agarwal HC, Gulati V, Sihota R. Visual field assessment in glaucoma: Comparative evaluation of manual Kinetic Goldmann Perimetry and Automated Static Perimetry. Indian J Ophthalmol [serial online] 2000 [cited 2011 Jun 15];48:301. Available from: http://www.ijo.in/text.asp?2000/48/4/301/14839

The most useful parameters for evaluation of glaucoma status in primary open-angle glaucoma are intraocular pressure (IOP), optic disc cupping and visual field assessment. Perimetry is an objective

method of assessing the visual damage; therefore, visual field assessment through perimetry is important in the diagnosis and management of primary open-angle glaucoma. Prior to the advent of automated perimetry, the Goldmann perimeter was used to detect visual field defects and their progression. It is rapid and covers a wide area. The installation and maintenance cost is not high. However, the perimetrist's involvement in measuring and assessing the visual fields on the Goldmann perimeter may introduce an element of subjectivity; this remains the chief drawback of manual perimetry. The superiority of the Goldmann perimeter is adequately supported in the literature.[1-5] Automated perimeters are objective, accurate and supported by useful software packages to assist in the assessment of the visual fields. At the same time, the cost of objectivity is high in financial terms; the Humphrey visual field analyzer costs about Rs. 200,000 more than the Goldmann perimeter at the time of the study. Automated perimeters have now mustered adequate support in ophthalmic literature.[6-10] Several studies have highlighted the usefulness of both methods of perimetry. [11,12] However, in India, resources being limited, cost is an important consideration. Hence, the two methods of perimetry were compared with regard to detection and assessment of progression of visual field defects.

Materials and Methods

Fifty-four patients were randomly selected from the glaucoma clinic or the outpatient department of the Rajendra Prasad Centre for Ophthalmic Sciences, New Delhi, India. They were categorized as primary open-angle glaucoma if the IOP was > 21 mm Hg with glaucomatous disc changes and /or visual field defects of glaucoma and a widely open angle on gonioscopy. The diagnosis of ocular hypertension was established if the IOP was > 21 mm Hg on two consecutive occasions without optic disc and visual field changes of glaucoma. A value of 21 mm Hg as a cutoff has been considered statistically valid.[13] Cases with other types of glaucoma, visual field loss due to causes other than glaucoma and eyes with a best corrected visual acuity less than 6/12 were excluded from the study.

In all patients a detailed clinical history of frequent change of presbyopic correction, impaired dark adaptation and visual field defects was recorded. A history of past and present medical therapy and surgical/laser treatment of glaucoma was noted. A complete ocular anterior segment slitlamp examination was conducted in oblique illumination under magnification. Fundus examination was performed with a direct ophthalmoscope to document the degree of optic disc cupping and to rule out any other lesion of the optic disc or the retina. Stereobiomicroscopic examination of the disc was done through the contact lens of the gonioscope at the time of gonioscopy, but a +90 D examination was not done. Refraction with/without cycloplegia was conducted to obtain the best corrected visual acuity for near and distance. IOP was measured using the Goldmann applanation tonometer. Diurnal variation of IOP on topical anti-glaucoma therapy was recorded. Gonioscopy was done to confirm the open status of the angle and to rule out other types of glaucoma. During follow up, random applanation tonometry was performed. If the IOP was recorded above 21 mm Hg a repeat diurnal was recorded and the anti-glaucoma therapy was adjusted to lower the IOP below 21 mm Hg.

Visual field assessment was done first on the Goldmann perimeter (model S-940, Haag Streit, Berne, Switzerland) followed by Humphrey visual field analyzer (model 735, Humphrey Instruments, Carl Zeiss, Germany). The visual field assessment on both perimeters was carried out on the same day. Patients on topical pilocarpine were advised to stop instillation of the drug 48 hours prior to examination and were temporarily put on oral acetazolamide, 250 mg four times a day to ensure a pupil size of more than 2.5 mm. A second visual field examination was done on

HVF analyzer after two days. In case of improvement, original defect was considered as learning effect and another visual field examination was done. On obtaining two successive consistent visual fields, the learning effect was deemed to be eliminated. Also, in case of poor patient cooperation due to fatigue or any other reason leading to unreliable fields, Humphrey visual fields were obtained on a subsequent date. Patients with consistently unreliable visual fields were not included in the study.

Visual field assessment on Goldmann perimeter was done by kinetic method with suprathreshold checks. Goldmann perimetry was performed on all cases by a single physician (VG). Three isopters I-4e, I-3e and I-2e were initially plotted for all patients. Near correction was used in the presbyopic age group and the requisite refractive correction in others before charting the visual field. Fixation was monitored throughout using the telescope.

Visual field assessment on the Humphrey visual field analyzer was done using full threshold program 30-2. A size III white stimulus was used for the assessment. The entire test was supervised and the patient was actively encouraged to maintain fixation throughout the test. A printout of the visual fields was obtained at the end of the examination. The visual field examination was done at intervals of 0, 3, 6 and 9 months.

Goldmann fields were analyzed for presence of any visual field defect (VFD) and its progression by one consultant physician (HCA/RS). On Goldmann perimeter, the criteria for detection and progression of a visual field defect were the same as used by Chauhan et al[13] [one or more scotomas with a minimum width of 5°, a horizontal nasal step with one isopter (or the sum of steps with multiple isopters) of at least 10°, presence of sector-shaped defect]. Each field defect was counted as an individual field defect. For example, a nasal step and a paracentral scotoma on a field were counted as two visual field defects on that field. The progression on Goldmann perimeter was defined using the criteria outlined by the same author [appearance of any of the above on a previously normal field; kinetic enlargement of a scotoma by at least 5°, in any direction or increase in horizontal nasal step with 1 isopter (or the sum of steps with multiple isopters) of at least 10°].

On HVF analyzer, the criteria used for detection and progression of a visual field defect were the same as that described by Anderson[14] [pattern deviation plot showing a cluster of 3 or more non-edge points at an expected location that have sensitivities occurring in fewer than 5% of the normal population (p<5%), one of the points having a sensitivity that occurs in fewer than 1% of the population (p<l%) with CPSD having p<5%; and GHT outside normal limits]. A field was considered to have a visual field defect (VFD) if it satisfied the criteria used for the purpose of the study. If more than one location on the field satisfied the criteria, the field defects were counted accordingly. However, no statistical program was used to determine progression. Progression[15] included the appearance of a new defect in accordance with the definition of defect used for the purpose of the study and was confirmed on at least one subsequent field; increase in depth of the defect by at least 0.5 log units (5 dB) in pattern deviation on at least 3 contiguous locations confirmed on at least one subsequent field or increase in depth of the defect by at least 1 log units (10 dB) with an increase in depth of the defect by at least 0.5 log units (5 dB) in pattern deviation on a contiguous location. The trend towards progression was confirmed on at least one subsequent field.

Results

A total of 54 patients (28 males; 26 females) were included in the study. All patients had

involvement of both eyes. Both eyes of 51 patients and one eye in 3 patients (the other eye had poor vision) were included in the study, making a total of 105 eyes. Of these, 52 were right and 53 were left eyes.

The mean age of the sample population was 50.59 ± 15.81 years. The youngest patient was 14 years old and the oldest patient 82 years. Thirty patients (57 eyes) had a diagnosis of primary open-angle glaucoma; 17 patients (34 eyes) had ocular hypertension and 7 patients (14 eyes) had juvenile open-angle glaucoma. At the time of inclusion into the study, the mean IOP was 18.42 ± 3.16 mm Hg on anti-glaucoma medications. In eyes with IOP>21 mm Hg, anti-glaucoma medication was increased to bring the IOP below 21 mm Hg. During follow up, all patients had IOP<21 mm Hg with topical medications. The number of eyes controlled on one, two and three topical medications were 66, 35 and 4 respectively. The mean cup-disc ratio for the population was 0.53 ± 0.20.

At initial presentation [Figure - 1], Goldmann perimetry detected visual field defects in 23 (22%) eyes. HVF analyzer showed field defects in all these eyes; an additional 21 (20%) showed field defects on HVF analyzer alone, taking the tally of eyes with visual field defects on HVF analyzer to 44 (42%). By 3 months [Figure - 2], the same 23 (22%) eyes showed field defects both on Goldmann perimetry and HVF analyzer whereas 22 (21%) eyes showed field defects on HVF analyzer alone, taking the tally of eyes with visual field defects on HVF analyzer to 45 (43%). By 6 months [Figure - 3] 24 (23%) eyes showed field defects on Goldmann perimetry. HVF analyzer showed field defects in all these eyes; an additional 23 (22%) showed field defects on HVF analyzer alone, taking the tally of eyes with visual field defects on HVF analyzer to 47 (45%). By 9 months [Figure - 4], 26 (25%) eyes showed field defects on Goldmann perimetry. On HVF analyzer, besides these eyes, 22 (21%) additional eyes showed field defects. Hence at the end of the follow-up period, 48 (46%) eyes showed field defects on HVF analyzer.

For eyes with 0.3 to 0.4 cupping, Goldmann perimeter did not pick up visual field defects in any of the patients whereas HVF analyzer picked up visual field defects in 6 of 44 (14%) eyes at presentation. By 9 months, in the same subgroup, HVF analyzer picked up visual field defects in 8 (18%) eyes, whereas Goldmann perimeter still failed to show the presence of any field defects.

For eyes with 0.5-0.6 cupping both Goldmann perimetry and HVF analyzer showed a field defect in 5 of 29 (17%) eyes whereas HVF analyzer picked up visual field defects in another 8 (28%) eyes, i.e., the total number of eyes with visual field defects on HVF analyzer was 13 (45%). In the same subgroup, by the time of the 9-month follow-up visit, both Goldmann perimetry and HVF analyzer showed a field defect in 8 (28%) eyes, whereas HVF analyzer picked up visual field defects in 7 (24%) extra eyes; taking the tally of eyes with 0.5-0.6 cupping with visual field defects on HVF analyzer to 15 (52%).

With 0.7-0.8 cupping both Goldmann perimetry and HVF analyzer picked up glaucomatous visual field defects in 12 of 26 (46%) eyes, whereas in the same patients, the HVF analyzer picked up visual field defects in 7 (27%) additional eyes [a total of 19(73%)] at presentation. In this subgroup the figures remained the same by the 9-month follow-up visit.

For cupping of more than 0.8 both Goldmann perimeter and HVF analyzer picked up visual field defects in 6 of 6 (100%) eyes at presentation as well as at the 9-month follow-up period [Figures:1-4]. HVF analyzer picked up all eyes with visual field defects that were picked up by Goldmann perimeter. The other eyes with visual field defects picked up by HVF analyzer were in addition to those picked up by Goldmann perimeter.

At presentation [Figure - 1], Goldmann perimetry picked up 25 glaucomatous visual field defects in

23 eyes (6 nasal steps, 6 sector defects and 13 arcuate scotomas), which increased to 30 glaucomatous visual field defects in 26 eyes (7 nasal steps, 9 sector defects and 14 arcuate scotomas) by the end of the 9-month follow up [Figure - 4]. HVF analyzer at presentation picked up 56 visual field defects in 44 eyes (19 in paracentral area, 15 in nasal step area, 5 sector defects and 17 in arcuate area) which increased to 69 visual field defects in 48 eyes (28 in paracentral area, 17 in nasal step area, 4 sector defects and 20 in arcuate area) by 9-month follow up. The paracentral defect which was demonstrated on HVF analyzer could not be detected on Goldmann perimetry in the same eye at the same time [Table - 1].

At presentation [Figure - 1], in eyes with 0. 3-0. 4 cupping Goldmann perimetry detected no visual field defects (VFDs) whereas HVF analyzer picked up 7 VFDs in 6 eyes (3 in paracentral area and 4 in nasal step area). By the end of the 9-month follow-up [Figure - 4] Goldmann perimetry continued to show the absence of any field defect whereas the number of VFDs on HVF analyzer increased to 10 (6 in paracentral area and 4 in nasal step area) in 8 eyes. In eyes with 0.5-0.6 cupping, at presentation, Goldmann perimetry picked-up 5 VFDs in 5 eyes (2 nasal steps, 1 sector defect and 2 arcuate scotomas) whereas HVF analyzer picked up 18 VFDs in 13 eyes (9 in paracentral area, 3 in nasal step area, 3 sector defects and 3 in arcuate area). By 9 months in the same subgroup Goldmann perimetry picked up 9 VFDs in 8 eyes (3 nasal steps, 3 sector defects and 3 arcuate scotomas) whereas HVF analyzer picked up 23 VFDs in 15 eyes (14 in paracentral area, 3 in nasal step area, 2 sector defects and 4 in arcuate area). In eyes with 0.7-0.8 cupping Goldmann perimetry picked up 12 VFDs in 12 eyes (1 nasal steps, 3 sector defect and 8 arcuate scotomas) whereas HVF analyzer picked up 23 VFDs in 19 eyes (7 in paracentral area, 5 in nasal step area, 2 sector defects and 9 in arcuate area) at presentation. By 9 months in the same subgroup Goldmann perimetry picked up 12 VFDs in 12 eyes (1 nasal steps, 3 sector defect and 8 arcuate scotomas) whereas HVF analyzer picked up 27 VFDs in 19 eyes (7 in paracentral area, 7 in nasal step area, 2 sector defects and 11 in arcuate area). At presentation, in eyes with more than 0.8 cupping Goldmann perimetry picked up 8 VFDs in 6 eyes (3 nasal steps, 2 sector defects and 3 arcuate scotomas) whereas HVF analyzer also picked up 8 VFDs in 6 eyes (3 in nasal step area and 5 in arcuate area). By 9 months, in the same subgroup, Goldmann perimetry picked up 9 VFDs in 6 eyes (3 nasal steps, 3 sector defect and 3 arcuate scotomas) whereas HVF analyzer also picked up 9 VFDs in 6 eyes (1 in paracentral area, 3 in nasal step area and 5 in arcuate area) [Table - 1].

We found that at presentation, Goldmann perimetry picked up 25 visual field defects in 23 eyes (from 105 eyes), whereas HVF analyzer picked up 56 visual field defects in 44 eyes. At the 3-months follow up Goldmann perimetry picked up the same 25 visual field defects in 23 eyes, whereas HVF analyzer, at the same time picked up 56 visual field defects in 45 eyes. By the 3-month follow-up visit one eye had shown progression of visual field defects on both Goldmann perimeter and HVF analyzer whereas two additional eyes had shown progression of visual field defects on HVF analyzer alone. Similarly at the 6-month follow-up visit 3 eyes had shown progression of visual field defects on both Goldmann perimeter and HVF analyzer whereas 5 additional eyes had shown progression of visual field defects on HVF analyzer alone. By the 9-month follow-up visit 7 eyes had shown progression of visual field defects on both Goldmann perimeter and HVF analyzer whereas 7 additional eyes had shown progression of visual field defects on HVF analyzer alone [Table - 2].

Seven eyes that had shown progression of visual field defects on Goldmann perimetry also showed progression of visual field defects on HVF analyzer. The two sets of visual fields were correlated temporally as shown in [Table - 3]. Up to the 3-month follow up of these 7 eyes, one had shown progression of visual field defects on Goldmann perimetry whereas three had shown progression of visual field defects on HVF analyzer. By the 6-month follow up of these 7 eyes, three had shown progression of visual field defects on Goldmann perimetry whereas all 7 eyes had shown

progression on HVF analyzer. By the end of the 9-month follow-up, the remaining 4 eyes showed progression of visual field defects on Goldmann perimetry as well.

Discussion

Visual field assessment is mandatory for the diagnosis and management of primary open-angle glaucoma. The Goldmann perimeter is widely available, economical and easy to maintain. But it requires frequent calibrations and highly skilled technicians to do the visual field examination; also, it does not measure the depth of a scotoma. It gives a rapid, comprehensive coverage of the entire field and produces recognizable isopter patterns.[11] At the same time, it fails to detect the early diffuse loss of retinal sensitivity. It works well for the definition of the topography of the visual field defects and subsequent progression, but is less efficient in the detection of small field defects. It is more patient friendly, as patients find it less tiring and easier to maintain fixation.[5] However, there is the possibility of observer bias and it requires the technician's deep involvement in the assessment of the visual field. The automated perimeter eliminates observer bias. The test is easier and can be performed by less skilled technical staff. However, the equipment is more expensive to purchase and maintain. Automated perimetry is for defining the depth of a scotoma and progression in depth of a visual field defect. It is superior for detection of generalized depression of retinal sensitivity, which forms the earliest visual field defect and is often missed by the Goldmann perimeter.[12] This is partially offset by the fact that the visual angle between static locations in the commonly used programs is more than the upper limits of translocation error on kinetic perimetry, making the topography of field defects a statistical interpolation rather than actual measurement. The statistical analysis by the software in an automated perimeter is more quantitative and accurate, but at the same time the patient finds the test procedure more tiring and the maintenance of fixation during visual field charting more difficult.[5] In the literature there is no consensus regarding the superiority of one perimeter over the other and each of these has been found to have distinct advantages and disadvantages influenced by the stage of the disease and other variables of the examination procedure. [1, 4, 8, 12]

In our study, the automated perimeter picked up visual field defects in a larger number of eyes than the Goldmann perimeter. The difference was greatest for eyes with early cupping, which narrowed down progressively with increasing cup-disc ratio. Visual field defects were more extensive on automated perimetry compared to Goldmann perimetry. The paracentral area visual field defects picked up by the HVF analyzer failed to show up on the Goldmann perimeter. The other area of major discrepancy between the two perimeters was the nasal step. The number of visual field defects in the nasal step area picked up by HVF analyzer was about 2.5 times as many as on Goldmann perimeter. The discrepancy for sector defects and arcuate area defects was less between the fields obtained by the two methods of perimetry.

HVF analyzer picked up progression in twice as many eyes as compared to the Goldmann perimeter during a follow up of 9 months. The superiority of HVF analyzer has clinical significance, because in a disease with largely irrecoverable visual field loss like glaucoma, it is important to pick up progression of visual field defects early so that the treatment may be modified or altered to prevent further visual field loss. The advantage of the HVF analyzer also lies in its ability to make use of quantified parameters like mean deviation and corrected pattern standard deviation to detect subtle worsening of visual field defect, with statistical level of confidence. This is beyond the detection capacity of the Goldmann perimeter. We conclude that automated HVF analyzer is superior to the Goldmann perimeter in detecting early glaucomatous visual field defects.[15]

References

1. Grochowicki M, Vighetto A, Berquet S, Khalfallah Y, Sassolas G. Pituitary adenomas:Automatic static perimetry and Goldmann perimetry. *Br J Ophthalmol* 1991;75:219-21. [PUBMED]
2. Heijl A, Drance SM, Douglas GR. Automatic perimetry (COMPETER). Ability to detect early glaucomatous field defects. *Arch Ophthalmol* 1980;98:1560-63. [PUBMED]
3. Keltner JL, Johnson CA. Effectiveness of automated perimetry in following glaucomatous visual field progression. *Ophthalmology* 1982;89:247-54. [PUBMED]
4. Stewart WC. Static versus kinetic testing in the nasal peripheral fields in patients with glaucoma. *Acta Ophthalmol Copenh* 1992;70:79-84. [PUBMED]
5. Trope GE, Britton R. A comparison of Goldmann and Humphrey automated perimetry in patients with glaucoma. *Br J Ophthalmol* 1987;71:489-93. [PUBMED]
6. Dyster Aas KJ, Heijl A, Lundqvist L. Computerized visual field screening in the management of patients with ocular hypertension. *Acta Ophthalmol Copenh* 1980;58:918-28.
7. Hotchkiss ML, Robin AL, Quigley HA, Pollack IP. A comparison of Peritest automated perimetry and Goldmann perimetry. *Arch Ophthalmol* 1985;103:397-403. [PUBMED]
8. Katz J, Tielsch JM, Quigley HA, Javitt J, Witt K, Sommer A. Automated suprathreshold screening for glaucoma:The Baltimore Eye Survey. *Invest Ophthalmol Vis Sci* 1993;34:3271-77. [PUBMED]
9. Mills RP. A comparison of Goldmann, Fieldmaster 200 and Dicon AP2000, perimeters used in a screening mode. *Ophthalmology* 1984;91:347-54. [PUBMED]
10. Portney GL, Krohn MA. The limitations of kinetic perimetry in early scotoma detection. *Ophthalmology* 1978;85:287-93. [PUBMED]
11. Batko KA, Anctil JL, Anderson DR. Detecting glaucomatous damage with the Friedman analyzer compared with the Goldmann perimeter and evaluation of stereoscopic photographs of the optic disc. *Am J Ophthalmol* 1983;95:435-47. [PUBMED]
12. Beck RW, Bergstrom TJ, Lichter PR. A clinical comparison of visual field testing with a new automated perimeter, the Humphrey Field Analyzer, and the Goldmann perimeter. *Ophthalmology* 1985;92:77-82. [PUBMED]
13. Chauhan BC, Drance SM, Douglas GR.The use of visual field indices in detecting changes in the visual field in glaucoma. *Invest Ophthalmol and Vis Sci* 1990;31:512-20.
14. Anderson DR. *Automated Static Perimetry*. St. Louis, MO:Mosby Year Book, 1992.
15. Richt R, Shields MB, Krupin T. *The Glaucomas*, 2nd ed. St Louis, MO:Mosby Year Book, 1996.

Figures

[Figure - 1], [Figure - 2], [Figure - 3], [Figure - 4]

Tables

[Table - 1], [Table - 2], [Table - 3]

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